

**MODIS Team Member - Semi-Annual Progress Report  
Marine Optical Characterization  
July-December 1994**

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## SUMMARY

During the past six months the MOCE Team conducted two cruises (deep mooring replacement cruise in early September and a bio-optical process cruise in October-November), collecting (following SeaWiFS protocols) biological and optical data for the development of improved *in situ* remote sensing algorithms. In addition, new systems and techniques were tested and are in the process of being evaluated. The operations schedule for the MOBY system deployments and the SeaWiFS Cal/Val cruises is shown in Figure 1. A great deal of effort was dedicated to repairing instrumentation which was damaged during power failures and a dead short which occurred during the MOBY-L7 cruise in June/July. The MOCE-3 cruise was conducted from October 27 to November 15 around the Hawaiian Islands and resulted in 16 stations of bio-optical measurements and 2800 km of track line data. p. 22

Work continued on the fabrication of the MOBY-2 versions which are to be deployed the SeaWiFS cal/val activities. Design modifications were submitted to Mooring Systems, Inc. and a contract was awarded for construction. American Holographic, Inc. designs for the new spectrographs were reviewed and after several iterations were accepted. A contract was awarded for the construction of ten new systems. Fabrication of buoy components by MLML personnel is 90 percent complete. The MOBY-2 systems are scheduled for assembly in Hawaii during March 1995.

## INSTRUMENTATION

MLML personnel tested the new CTD and its SeaRAM onboard recording system in Moss Landing Harbor and completed construction of 12 17-liter water samplers for use on the CTD/Carousel. These large volume samplers are required to obtain sufficient water for suspended material and pigment analyses. The new MLML samplers have machined O-ring/spherical caps designed after a commercial sampling bottle. The samplers are metal free and use Vitron O-rings to avoid metal contamination. The space for two samplers is taken-up by the transmissometer. If the transmissometer is removed, this profiling system has a maximum capacity for 12 samplers (Fig. 2).

The new third generation Tet buoys have been built and shipped to Hawaii. After additional bracing was added, this modified buoy system proved to be extremely stable in high wind and sea conditions (25 kts and 15 foot seas).

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The MLML/Martek transmissometer and MLML three-channel fluorometer were shipped to Moss Landing for integration with the new SeaBird profiling CTD system. Personnel from San Jose State University redesigned the transmissometer optics and electronics to provide a low-current, high stability system for determining beam attenuation.

A small battery pack with magnetic reed switches to supply power to the three-channel fluorometer and transmissometer has been built. When the new transmissometer electronics is finished, attempts will be made to power the redesigned transmissometer from the Sea-Bird CTD directly. Cables were ordered to marry our optics sensors to the CTD, however some connectors were not received before the MOCE-3 cruise. It was necessary to use bulkhead connectors from the old MLML CTD-Rosette; these were spliced to new cables for the Sea-Bird system. One of the old CTD connectors began to fail near the end of the MOCE-3 cruise.

### **MOBY-L8 CRUISE**

Ship time was from September 9-13, 1994. The primary purpose of the cruise was to retrieve the MOBY mooring buoy, which had been in the ocean for approximately 1 year and replace the entire system with a new system (Fig. 3).

The following personnel were involved:

NOAA - Dennis Clark, Edward King, and Eric Stengel  
MLML - Mark Yarbrough, John Yarbrough, and Mike Feinholz  
NASA - Stanford Hooker

Shore support personnel: Phil Hovey - NOAA

The surface float electronics appeared to be in good shape. None of the signal lantern lamps had failed and the battery was in good condition. The only potential trouble spots were tangling and chafing of the nylon section and a problem with a twisted shackle (Fig. 4). The surface float needs to be refinished as soon as possible to serve as a backup if needed. Additional line and parts must be ordered to have a full backup mooring available before the next MOBY deployment.

The replacement mooring deployment was conducted in 30 kt winds and 5 ft seas but was executed without problems. In future deployments, a modification to the hard hat chain configuration will be implemented so that aspect of the mooring deployment can be conducted more smoothly.

During the MOBY-L8 cruise, several SeaBird CTD casts were made to evaluate the system under realistic conditions. The CTD worked well, but more research is needed regarding the SeaRAM software to collect and playback data recorded internally. The SeaRAM hardware functioned properly, but some details of its software require further study.

After the cruise routine maintenance was completed. Using a rented hydraulic articulating lift (40') the MOBY tent was washed and inspected (Fig. 5). A storage shed was built to house large tools, power washers, and miscellaneous items.

## **ELECTRICAL GROUNDING PROBLEM**

During the MOBY-L8 cruise, some valuable equipment was lost due to an electrical grounding problem on the R/V Moana Wave. The winch slip-rings suffered an internal short during a vertical profile. Poor wiring within the slip-rings led to chafing and the eventual shorting of a pump power ring to the TX serial and ground leads from the Parascientific pressure sensor. The short allowed high AC voltages to travel through the Pressure Sensor and MODAPS deck unit and arc across to the communications lines within MODAPS which lead to the Toshiba 1910CS laptop. The short ultimately fused a transformer within the pump power supply and wires within the slip-rings. The only overload protection of the system is through the pump motor, but because of small wires in the pumping cable, the cable is not well protected. Fuse protection for this situation poses a problem because the fuse chosen must allow for the high starting currents required by the motor.

The slip-ring short caused additional damage to other AC systems within both computer huts because the ship transformer supplying power was not grounded at the transformer. With no neutral connection to ground a short on any of the three hot legs caused the neutral voltage (referenced to ground) to rise to 120 volts and the other two hot legs to rise to 220 volts. This caused a fault condition within the surge protectors (the protection elements are referenced to ground) and resulted in the destruction of all the surge protectors plugged in at the time.

This type of ungrounded power system is common on ships. Running the power system ungrounded reduces currents flowing through the hull which decreases the rate of hull corrosion and extends the life of the hull zincs. On most ships, the types of fault observed would have set off an alarm in the ship's power system. The transformer on the R/V Moana Wave is an add-on and has no such monitoring or protection circuitry.

The R/V Moana Wave engineers have grounded the transformers which should eliminate future problems at the expense of their hull zincs and fittings. They will no longer wire the on-deck electrical connections to provide 120/240 power. Instead, they will all be 208 volts, 3-phase. We can safely operate 208 v, 1 to 3-phase equipment from the ship's power, but we must supply our own 120 volts power. A massive effort was required to build a power conditioning van to supply clean, regulated power to the three seagoing huts: the radiometry van, the along-track profiling and meteorology data acquisition van, and the pigment analysis van. Two ten-foot vans were ordered. One van will become a clean lab. The other was outfitted at the MOBY Sand Island facility to supply clean power to the science vans. This included installing windows, doors, insulation, interior walls, and light fixtures. Following that, instrument racks, circuit breakers, power switches, uninterrupted power supplies (UPS), and 440/120 VAC transformers were installed. Heavy duty

power cables were run to the various science vans. This power hut can be operated on almost any ship that can provide 440 volts, 3-phase power. Loads can be split between the ship's 440 volts and 208 volts systems, as will be required on other research vessels.

Power drain from the laser printers or other heavy loads causes an apparent phase shift in the power from the power hut. The only equipment affected by this phase shift is the small Best UPS units. The solution is to run the computers from the power hut UPS circuits directly. Heavy load items will be run from the non-UPS circuits within the van. Critical loads requiring individual UPS protection could be run from the non-UPS power through one of the small Best units. The startup load of the big air conditioning units seemed to be too much for the UPS units to power. These units are now run from the power hut's transformer to provide proper voltage and grounding. A possible option would be to add more transformer connectors to the power hut to support additional vans. Additional computer huts could then be connected to the extra UPS units.

### **MOCE-3 OPTICAL CHARACTERIZATION CRUISE**

The MOCE-3 optical characterization cruise was conducted from October 27 to November 15. The following personnel participated:

NOAA - Dennis Clark, Yuntao Ge, Phil Hovey, Ed King, Eric Stengel, and Marilyn Yuen  
MLML - Mark Yarbrough, Mike Feinholz, Stephanie Flora, and Drew Gashler  
CHORS - Charles Trees and Dan Sullivan  
NASA - Stan Hooker  
University of Miami - Jim Brown, Yi Liu, and Ken Voss  
University of Hawaii - Mike Ondrusek  
Shore Support Personnel: Todd Hunter - MLML

This cruise aboard R/V Moana Wave was conducted in and around the major Hawaiian Islands and westward to the French Frigate Shoals approximately 600 miles northwest from Oahu. The ship track and 16 station locations are illustrated in Figure 6.

Samples were collected for HPLC and fluorometric determination of phytoplankton pigments, cyanobacteria pigments, total particulate and detrital absorptions and reflectance, and dissolved organic material absorption. In addition, vertical profiles were made using a MER1032 radiometer, a stimulated fluorometer, a beam transmissometer, and a 9-channel absorption/attenuation meter (AC9). Below is a partial list of the number of samples collected and/or profiles made:

<u>MEASUREMENT</u>	<u>NUMBER OF SAMPLES OR PROFILES</u>
Total Suspended Matter	180
Particulate Organic Carbon	120
Salinity	120
Oxygen	100
Total Particulate Absorption	230
Detrital Absorption	230
Total Particulate Reflectance	230
Detrital Reflectance	230
Dissolved Organic Absorption	131
HPLC Pigments	215
Fluorometric Pigments	275
Cyanobacteria Pigments	70
MER 1032 Profiles	19
AC9 Profiles	19
CTD Profiles	19
Radiometric Profiles	16

During the cruise separate samples were collected for fluorometric determination of chlorophylls and phaeopigments. An example of these data for both along track and vertical profiles is shown in Table 1. The fluorometric calibration of the fluorometer (Turner Designs Model 10) is shown in Table 2. On November 5, a grid survey was performed around the University of Hawaii's Hawaiian Ocean Time Series (HOTS) site to study within-pixel variability at spatial scales similar to SeaWiFS/MODIS fields of view. During this survey, triplicate fluorometric chlorophyll samples were collected every 15 minutes from a towed pumping system. This grid pattern and the associated chlorophyll contours are shown in Figure 7, along with the Min, Max, Mean, and Std Dev for the data.

A comparison was made between extracted chlorophyll concentrations and relative fluorescence measured with a Chelsea fluorometer that was being towed on the pumping system. No effort was made to correct for the time delay (1-2 minutes) between the submerged pump and the sample being collected in the filtration van. A plot comparing relative fluorescence to chlorophyll concentrations for all the data is shown in Figure 8d. To evaluate the effects of day and night differences and along-track pumped samples versus vertical pump samples, these data have been separated and plotted in Figures 8a, 8b, and 8c. Little improvement was found in describing the variance of the data when day and night samplings were separated. However, there was a marked improvement in the  $r^2$  for the vertical sampling group. This is attributed to the fact that at each sampling depth the pump was stopped for a flushing time of 6-10 minutes prior to sampling. This time delay insures that the water sample is representative of that depth. Unfortunately, this cannot be accomplished for the along track sampling.

The particulate absorption data was printed out during the MOCE-3 cruise. The  $\beta$ -correction, volume filtered, and clearance area factors will be applied to data in the

next few months. DOM absorption values in the visible around the Hawaiian Islands were at the noise level of the spectrophotometric measurement technique using a 10 cm path length cell. Increasing the path length of the cell seems to be the only viable option for improving DOM absorption measurements.

During the cruise, the particle size analysis data was collected daily and imagery of the particles was documented with a video microscope system. The particle counter blew a resistor on November 4, so there was no data collected on that day. After the paravane was damaged, it was necessary to use the ship's sea chest for along track profiling. Plumbing was run from the sea chest, which is located near the bow, to the on-line. Table 3 shows an example of along-track data compiled by the particle counter.

Data from this cruise are either in Macintosh format, MLML PLOT format, or DOS format. The MOS, SIS, and Fastie data are in MLML PLOT format. All of these data sets have been transferred from MLML to NOAA (via Internet) and are ready for processing.

## **MOCE INSTRUMENTATION**

### **Marine Optical Systems**

During the MOCE-3 cruise, MOS failed following a rough deployment. MOS stopped communicating because the jolt resulted in the disconnection of an internal connector on the Serial Interface Board. MOS was disassembled on the ship the repair and may require disassembly and cleaning prior to the next calibration. The new MOS will have all latching style connectors to prevent this kind of shipboard failure in the future.

On November 9 the MER1032 flooded because a connector broke the previous day during retrieval efforts. The instrument was rinsed with fresh water and methanol and then stored for calibration back at CHORS. Because of this accident, there is a limited data set of MER and AC9 profiles. It was also noticed prior to the flooding that the Lu 490 channel on the MER1032 was not recording data. A loose connection was discovered during the cleaning.

The VLST also flooded because the quartz window cracked during a vertical profile on the pumping system. Again, the instrument was taken apart and washed with water and methanol. The instrument was shipped back to the University of Miami for maintenance and calibration.

### **Towed System**

Electrical problems developed on the MOBY-L8 cruise caused severe damage to several instrument systems including the power supply for the along-track paravane pump and winch, the winch's slip-rings, the pump, the Chelsea fluorometer, the AC-9 absorption meter, the MODAPS data acquisition system, the Digiquartz pressure

transducer, and two data acquisition computers. This required about a month to replace or repair damaged equipment.

The pumping winch slip-rings and the transformer within the pump power supply were replaced. Overload protection was added to all sensors at both ends of the system and to the pump controller on the output side of the supply before the slip-rings. Overload protection was also added to the pump power supply by changing the ship's breaker over to the proper amperage for the system (20 amps).

The Parascientific Pressure Sensor was repaired and replaced. The vertical fin still needs to be replaced. Also, careful inspection of the instrument is needed following rough deployments or recoveries. A rack must be built to hold the fins in an orientation that will prevent stress on the mounts. This will be even more important with the proposed larger fin. More frequent general inspection of the towed components should be performed. The mounts must be disassembled to do this properly.

The Chelsea fluorometer's failing resistor was replaced and the unit seemed to operate normally for the rest of the MOCE-3 cruise. The unit is being returned to the manufacturer for factory repair and test.

The project now possesses all the tools necessary to maintain the cable faring. Twisting of the faring continues to be a problem. The Zippertubing faring still needs to be tested. The small piece tested was not too impressive, but the Zippertubing system still seems usable as a backup.

### AC-9

During the MOBY L-8 cruise, 3 air cal runs and 2 clean water runs were performed. Clean water runs used the new pump in a recirculating system. The air cal data seemed more stable than before and reproducible to 0.005 absorbance units for all channels except the two blue channels which were 0.02 units. Transmission was repeatable to 0.02 to 0.05 units. Clean water repeatability was similar and seemed less prone to bubbles. The AC-9 generally operated in a more rational way and was starting to show wavelength structure during a vertical profile when it was damaged internally by the slip-ring short.

During MOCE-3, emphasis was on methods to improve data quality and evaluate the performance of the AC-9 and MODAPS instrumentation. Calibration data consisting of air and "pure" water data sets was collected every 3 to 4 days. The AC-9 transect and profile data were collected throughout the cruise. The AC-9 was found to have internal condensation at the time of the second air cal run. The instrument was purged and desiccated. The AC-9 had a signal noise problem throughout the cruise.

The following tests were performed on the AC-9 during the cruise:

- Air cal reproducibility. Shipboard air cals are reproducible to better than 3%. Comparisons of shipboard and factory calibration differ by 20 to 50%.

- Instrument noise measurements. Standard deviations for the AC-9 measurements should be  $< 0.001$  units. The noise for all measurements during the cruise were on the order of 0.0025 to 0.003 units. The problem was fixed at WET Labs. The noise was caused by a loose filter wheel.

- Cleaning technique comparisons. Our in-house cleaning technique produces better reproducibility than the published cleaning protocols. The published protocols are the best cleaning method only if a source of dry nitrogen is not available. Shipboard cals are reproducible, but they differ greatly from the factory values. In all cases the differences indicate that we clean the instrument better than the factory.

- Comparisons with the CHORS AC-9 unit. The CHORS shipboard air cals also differ from the factory cals by a similar magnitude. CHORS finds their cleaning methods to be the same or better than the protocols. CHORS air cal values are also cleaner than the factory values. Both instruments agree that in terms of absorption the Milli-Q polished water may be slightly purer than the BJ HPLC grade pure water. In terms of attenuation, the CHORS instrument yields results that demonstrate that the Milli-Q water is superior. Results from our instrument favor the BJ water. The difference between the waters are on the order of 0.02 attenuation units.

Correcting AC-9 attenuation by applying shipboard air cal values does not correct the inconsistencies observed in the wavelength structure of the natural waters being sampled. The AC-9 seemed to operate well in the freezer.

### MODAPS

The MODAPS unit had a power-up initialization problem. It was returned to WET Labs for repair. The failure was due to an intermittent open connection on the deck unit circuit board. Currently, there is no software to perform the extraction and merging of MODAPS archive files.

### Laser Scattering Meter

Prior to the MOCE-3 cruise the scattering coefficient meter was reconfigured, the optics realigned, the electronics rewired, and the new calibration procedure was added. HPLC grade pure water is now used as a calibration source for the laser scattering instrument. The system was calibrated with pure water several times a day.

During the cruise it was found that the signal cable for the scattering meter was picking up random noise from other systems on the ship. The random noise was reduced to the level of about 5 mV at a signal level of 600 mV. After the signal cable was replaced with a shield twisted-pair wire, a lowpass filter was installed, and better grounding was provided for the amplifiers.



## **CALIBRATION**

The Gamma 500 FEL calibration system was reworked at EG&G to include the NIST recommended improvements and delivered in time for SIRREX-3 at CHORS from September 25-28. During that work, the Gamma 500 radiance source was calibrated with new baffling and a light trap that agreed well with NIST standards. In addition, intercalibration data for the Optronic 420 system, as well as two FEL sources (F307, F308), the HP 34401A voltmeter, 10" plaque, and Weston Shunt GS125 were obtained.

During the MOCE-3 expedition pre-cruise and post-cruise, absolute radiometric calibrations (Gamma Scientific GS5000/GS922 FEL lamp integrating sphere and baffling system; Optronics Labs 420M radiance source), drift reference sources (Gamma Scientific RS10A irradiance source), and wavelength calibrations (Oriel Spectral Calibration Lamps: Ne and HgAr) of MOS (Marine Optical System), SIS (Surface Irradiance Spectrometer) and Fastie (80-channel scanning radiometer) were performed in the MOBY operations tent. It was found that after RSI refurbished Fastie, the high voltage offset had been changed. The new calibration data were used to derive a new regression relationship for high voltage settings.

The pre-cruise calibration of these instruments was conducted over four days. The post-cruise calibration was accomplished in two days. This reduction in time was accomplished by running two VAX systems simultaneously during the calibration process. A further reduction could be realized if the software could be developed which would operate all the instruments from one or two VAXs.

## **MARINE OPTICAL BUOY**

### **Software Development**

Personnel from MLML have completed MOS-2 system software to the point of testing it on the bread-board MOS-2 simulator. The file transfer software for use on MOBY is near completion. In the immediate future, work will focus on debugging MOS and MOBY FORTH programs.

MOBY software development is being done in two steps. The first step is the MOS software. This is accomplished by testing the individual components of the MOS: CCD processing, fiber optic multiplexer, compass, mirror geneva motor, serial power control board, and the 16-bit analog data conversion. After the routines are fully debugged, these procedures will be integrated so that MOS will return data using the GD (i. e. Get Data) command. This will complete MOS programming.

The second step is to acquire hardware for the MOBY mockup. A way to simulate the batteries and the solar panels will be developed so the software can be realistically tested. Other components [TT5 (for lower buoy control and status), modem with cellular phone, Sutron (upper buoy control and status), GPS and the MOS mockup] will be assembled for testing the MOBY-2 software. The software testing will follow

the same procedures as MOS (test individual components, integrate, and test the entire system). An unresolved problem with Sutron is to find a way to put the program into EPROM so that Sutron retains its software when the battery voltage drops. Also, a small program will be added to schedule the Sutron to ensure that MOBY TT7 (the main computer) will be operational at its scheduled times.

### Hardware Development

The completion of a major electronics redesign of the MOS and the MOBY communications systems is continuing. Personnel from MLML have completed fabrication of the buoy lower instrument bays and are working on the mast fiberglass elements. Masts will be assembled when a desired length is decided upon. The batteries still need to be tested to see if they can withstand the pressure at 15 meters without pressure compensation. Surface float construction has not yet started.

MOS was disassembled to perform tests and modifications to the diode array detector system. An offset shifting problem was observed in some test data. Dark and signal charge accumulation is linear with time (at the integration times used) to better than 1%. The red array containing the sample hold preamplifier to the A/D converter seems less variable. This may be due to the slightly lower gain of the red preamplifier and the generally lower temperature of the red array. This problem could be internal to the PCD array or its amplifier or perhaps an interaction between the PCD system and the SC tech preamplifier. A portion of each array will be masked off in an attempt to provide baseline information with each scan. This is not expected to be as effective as the masking which is normally applied directly to the array surface, but it should be better than the current dark correction method.

The work on new MOS is continuing. All MOS systems requiring new program development have been prototyped and tested with the exception of the analog module which is basically the same as SIS and should not require new development. Board layout design and board manufacture are still in process.

### **DOCUMENTATION**

Moss Landing Marine Laboratories personnel have written two reports. They are a shipboard procedures manual, which was written and edited during the MOCE-3 cruise, and the MOCE-2 R/V El Puma cruise report.

Data from MOCE-1 and MOCE-2 have been transferred to NASA and the corresponding technical data reports are nearly complete.

### **SUPPORTING GRANTS AND INTERAGENCY ACTIONS**

Research and Data Systems Corporation contract was extended.

Transfer of ship funding to NSF was initiated.

Grant renewal to San Diego State University-CHORS was initiated.

**PERSONNEL**

No actions.

# MOCE Field Operations

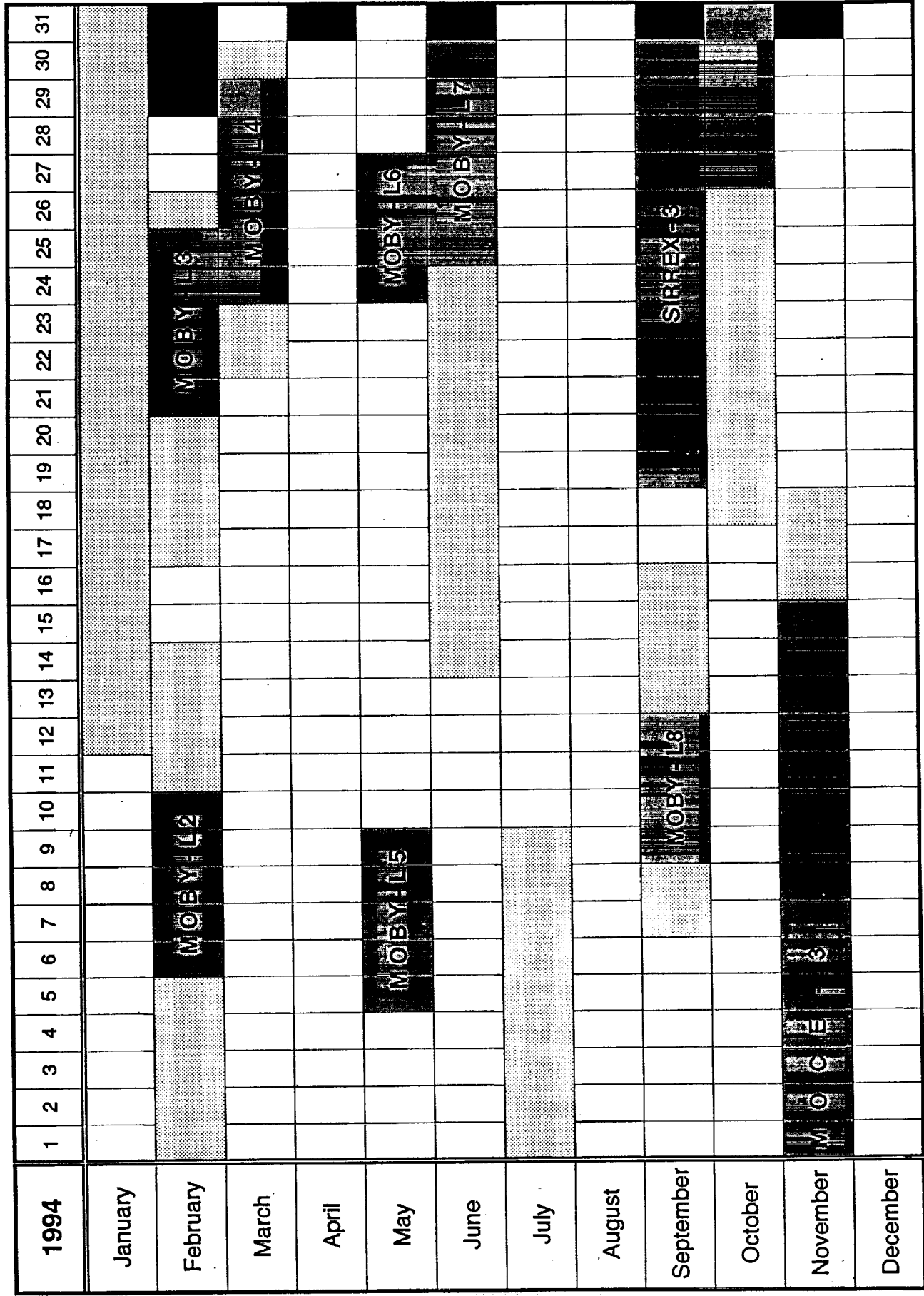
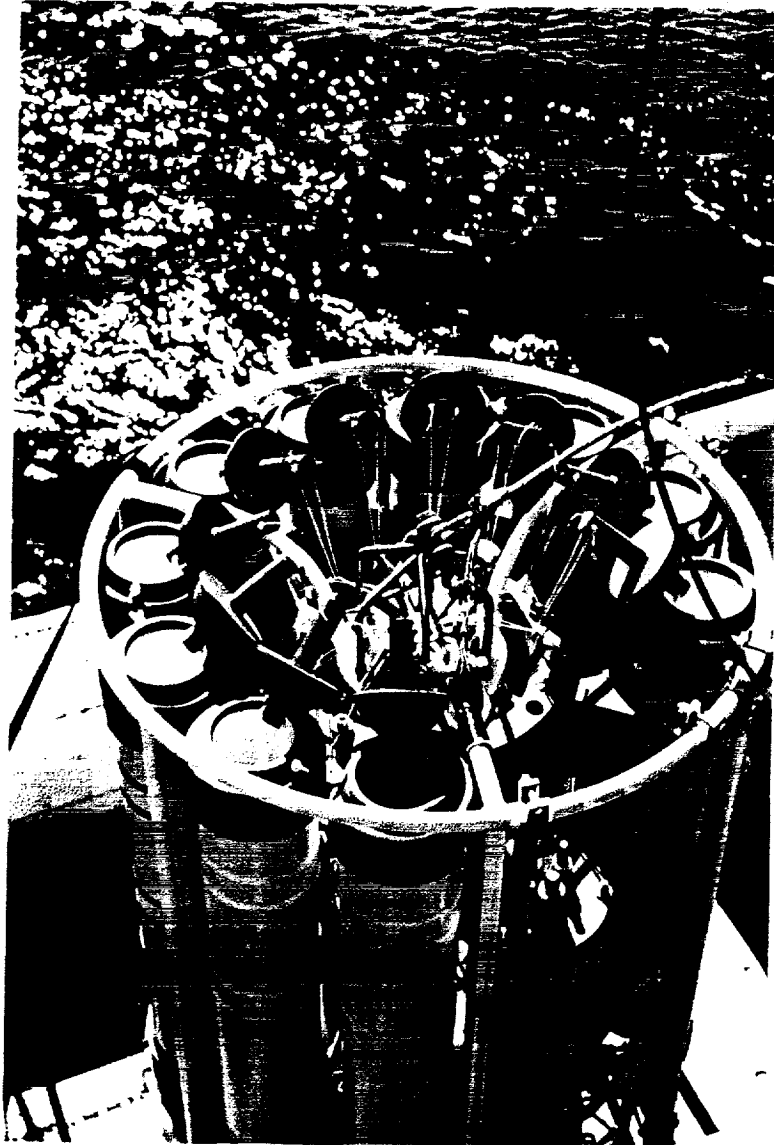


FIGURE 1.



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FIGURE 2.

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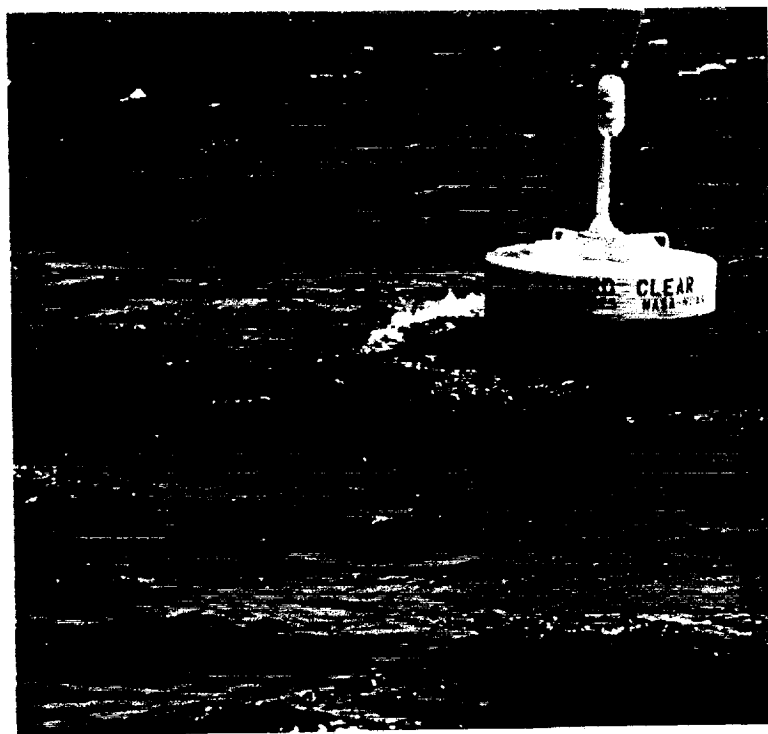


FIGURE 3.



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FIGURE 4.



FIGURE 5.



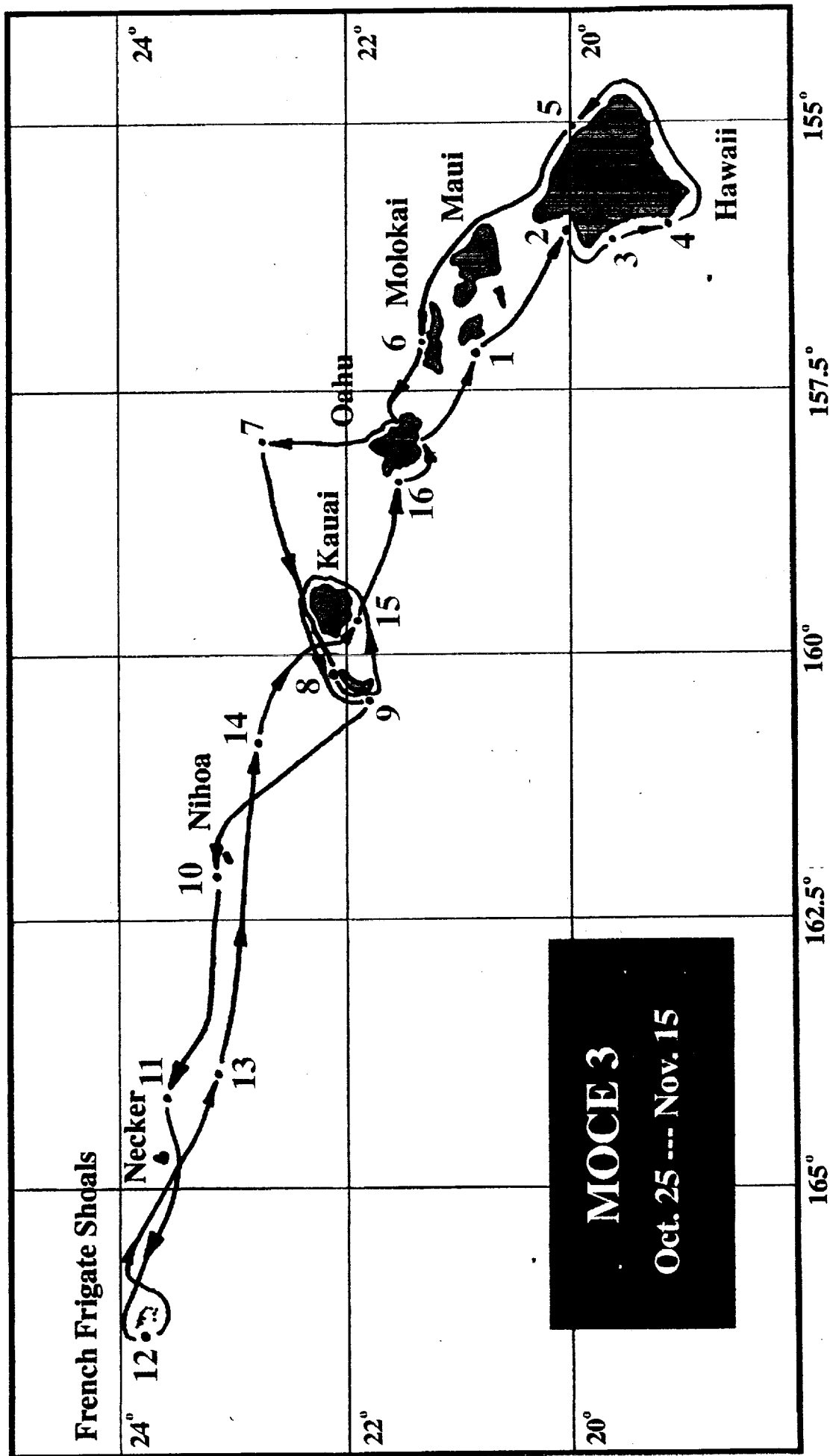


FIGURE 6.

# MOCE 3

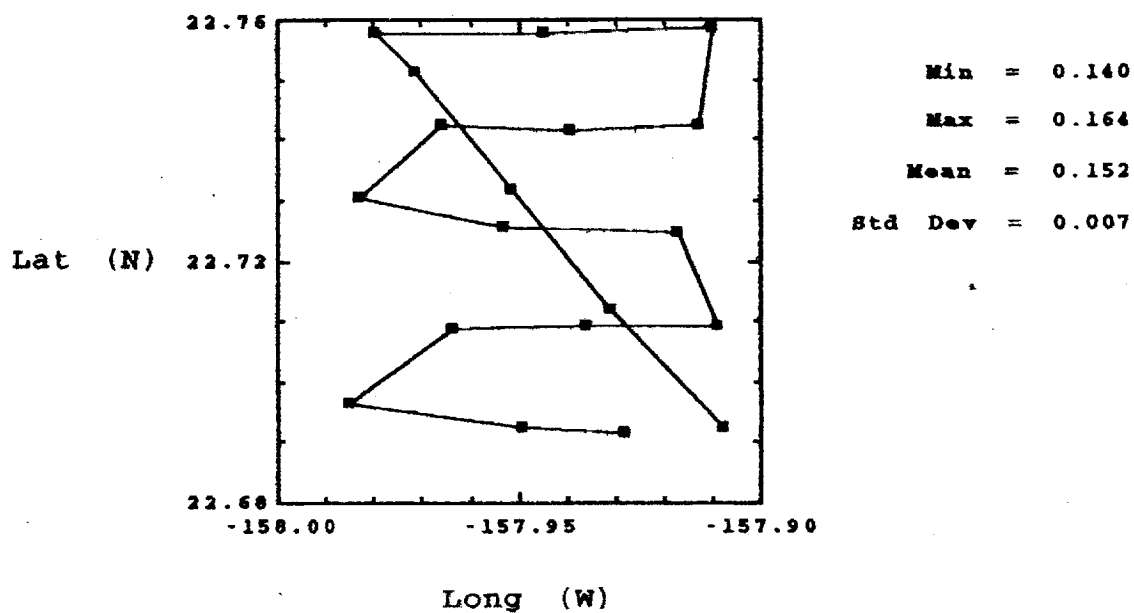
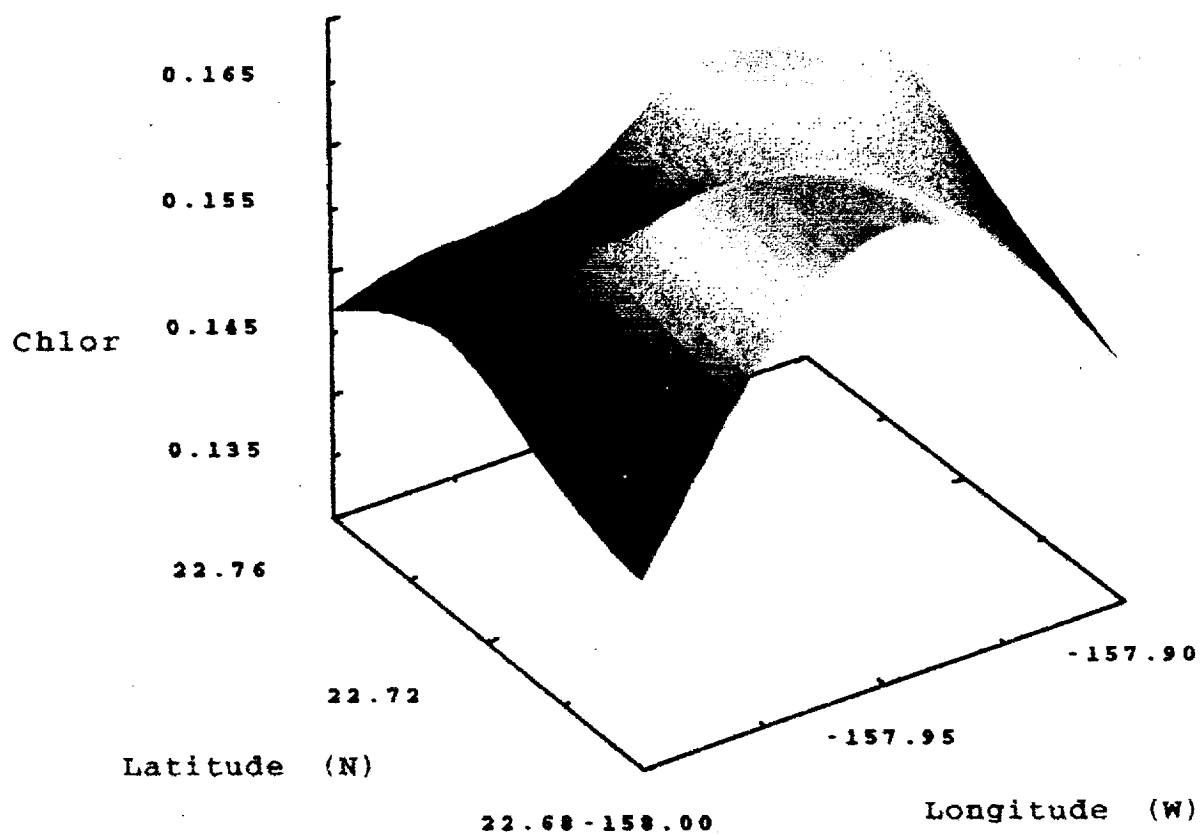
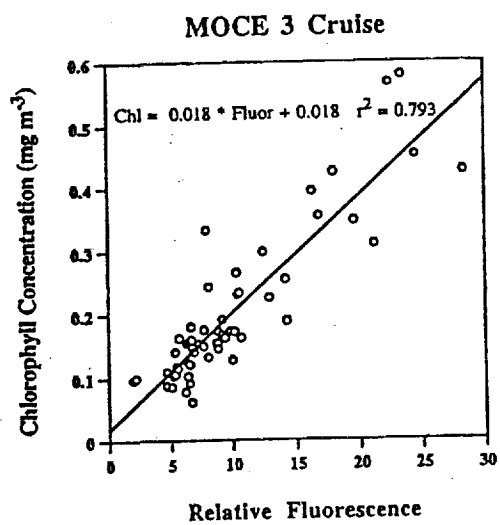
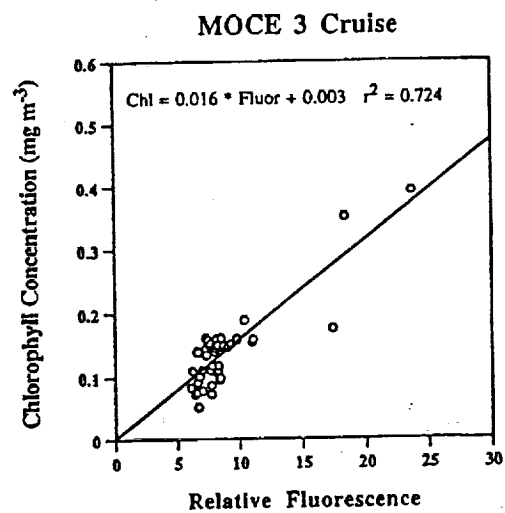


FIGURE 7.

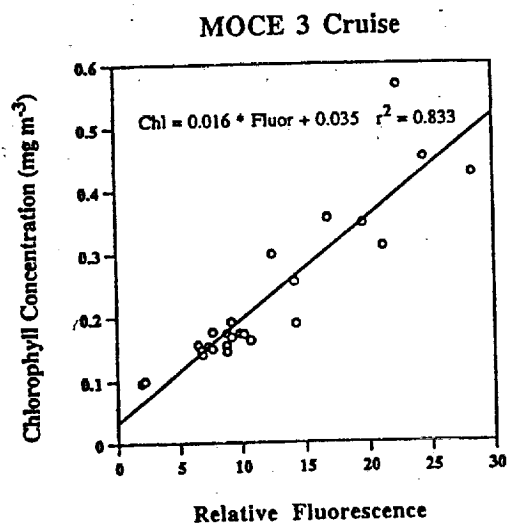
A



B



C



D

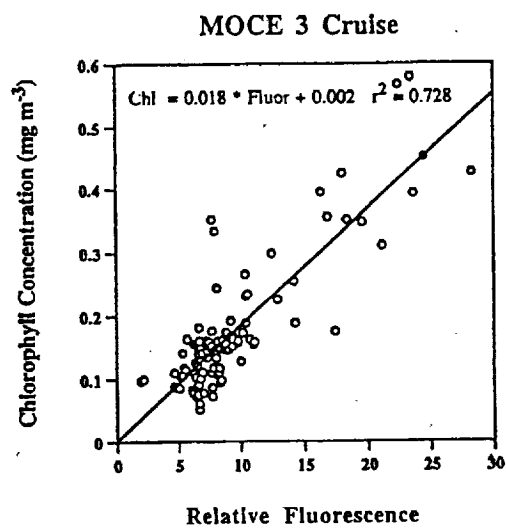


FIGURE 8.

**MOCE MOORING 3 CRUISE  
FLUOROMETRIC PIGMENT DATA**

Seq #	Sam #	Date (Julian)	Time (GMT)	Latitude (N)	Longitude (W)	Sta Name	Sta	Z (m)	V.Filt (ml)	V.Ext (ml)	Dr #	Fb	Fa	Dr Fact	Chl a (mg/m <sup>3</sup> )	Phaeo (mg/m <sup>3</sup> )
37	302	302	2151	20.8183	-157.1500	Lanai Mooring	CTD 1	1	500	10.15	31.6	1.999	1.190	3.132	0.100	0.056
38	302	302	2151	20.8183	-157.1500	Lanai Mooring	CTD 1	21	500	10.15	31.6	2.210	1.370	3.132	0.104	0.076
39	302	302	2151	20.8183	-157.1500	Lanai Mooring	CTD 1	41	500	10.15	31.6	2.712	1.438	3.132	0.157	0.032
40	302	302	2151	20.8183	-157.1500	Lanai Mooring	CTD 1	61	500	10.15	31.6	5.020	2.728	3.132	0.283	0.075
41	302	302	2151	20.8183	-157.1500	Lanai Mooring	CTD 1	81	500	10.15	10.0	2.703	1.646	10.702	0.439	0.311
25	303	402	402	20.7967	-157.0783		VLST 6	3	500	10.15	31.6	1.493	0.820	3.132	0.083	0.025
26	303	402	402	20.7967	-157.0783		VLST 6	15	500	10.15	31.6	1.714	0.899	3.132	0.101	0.017
27	303	402	402	20.7967	-157.0783		VLST 6	30	500	10.15	31.6	2.225	1.249	3.132	0.120	0.044
3	304	419					Alongtrack		900	10.15	31.6	2.681	1.500	3.132	0.081	0.028
1	303	824					Alongtrack		500	10.15	31.6	1.611	0.890	3.132	0.089	0.028
2	303	1004					Alongtrack		1140	10.15	31.6	2.200	1.239	3.132	0.052	0.019
32	303	2005	2005	20.0100	-155.9750	Kawaihae Bay	CTD 2	11	900	10.15	31.6	2.646	1.465	3.132	0.081	0.026
33	303	2005	2005	20.0100	-155.9750	Kawaihae Bay	CTD 2	41	900	10.15	10.0	1.915	0.998	10.702	0.212	0.041
34	303	2005	2005	20.0100	-155.9750	Kawaihae Bay	CTD 2	71	900	10.15	10.0	3.410	1.876	10.702	0.354	0.121
35	303	2005	2005	20.0100	-155.9750	Kawaihae Bay	CTD 2	91	900	10.15	10.0	2.999	1.785	10.702	0.280	0.172
36	303	2005	2005	20.0100	-155.9750	Kawaihae Bay	CTD 2	131	900	10.15	10.0	1.262	0.833	10.702	0.099	0.112
4	304	511					Alongtrack		900	10.15	31.6	2.395	1.329	3.132	0.073	0.024
5	304	805		20.7570	-157.0677		Alongtrack		900	10.15	31.6	2.502	1.368	3.132	0.078	0.022
6	304	903					Alongtrack		900	10.15	31.6	2.404	1.346	3.132	0.072	0.026
7	304	1003					Alongtrack		900	10.15	31.6	2.489	1.390	3.132	0.075	0.026
16	304	1900	1900	19.7217	-156.1183	Kaehole Point	CTD 3	2	900	10.15	31.6	2.893	1.560	3.132	0.091	0.022
17	304	1900	1900	19.7217	-156.1183	Kaehole Point	CTD 3	31	900	10.15	31.6	3.270	1.744	3.132	0.105	0.023
18	304	1900	1900	19.7217	-156.1183	Kaehole Point	CTD 3	71	900	10.15	10.0	2.313	1.285	10.702	0.237	0.088
19	304	1900	1900	19.7217	-156.1183	Kaehole Point	CTD 3	161	900	10.15	31.6	1.517	0.992	3.132	0.036	0.036
29	304	2114	2114	19.7467	-156.1333		VLST 8	3	900	10.15	31.6	3.048	1.625	3.132	0.097	0.021
9	304	2114	2114	19.7467	-156.1333		VLST 8	15	900	10.15	31.6	3.146	1.690	3.132	0.100	0.023

TABLE 1

**MOCE MOORING 3 CRUISE  
CALIBRATION DATA**

Std Volume	Total Vol	Concentration	Dr #	Fb	Fa	Blk	tau	Dr. Fact
1.00	9.00	113.05022	1.00	1.2450	0.6060	0.0015	2.054	90.91292
0.75	8.75	87.21017	1.00	0.9890	0.4750	0.0015	2.082	88.31410
0.50	8.50	59.85012	1.00	0.6740	0.3230	0.0015	2.087	88.99646
0.25	8.25	30.83188	1.00	0.3260	0.1570	0.0015	2.076	95.01349
						Average	2.075	90.80924
						Std	0.014	3.01100
						C.V	0.688	3.31575
1.00	9.00	113.05022	3.16	3.6100	1.7490	0.0043	2.064	31.35320
0.75	8.75	87.21017	3.16	2.8630	1.3720	0.0043	2.087	30.50693
0.50	8.50	59.85012	3.16	1.9460	0.9350	0.0043	2.081	30.82357
0.25	8.25	30.83188	3.16	0.9430	0.4520	0.0043	2.086	32.84530
0.10	8.10	12.56114	3.16	0.4250	0.2064	0.0043	2.059	29.85770
0.05	8.05	6.31958	3.16	0.2107	0.1003	0.0043	2.101	30.61811
						Average	2.080	31.00080
						Std	0.016	1.02516
						C.V	0.747	3.30689
0.75	8.75	87.21017	10.00	8.1700	3.9300	0.0073	2.079	10.68399
0.50	8.50	59.85012	10.00	5.5700	2.6790	0.0073	2.079	10.75918
0.25	8.25	30.83188	10.00	2.7030	1.2900	0.0073	2.095	11.43743
0.10	8.10	12.56114	10.00	1.2120	0.5800	0.0073	2.090	10.42677
0.05	8.05	6.31958	10.00	0.6080	0.2844	0.0073	2.138	10.52036
0.03	8.03	3.16963	10.00	0.3125	0.1487	0.0073	2.102	10.38543
						Average	2.097	10.70219
						Std	0.022	0.38818

TABLE 2

